SOME ASPECTS OF PHOTOSYNTHESIS IN MECHANIZEDLY PRODUCED TOMATO SEEDLINGS

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Abstract. To increase the culture quality it is absolutely necessary to improve the methods of obtaining the seedlings. This paper refers to the photosynthesis processes of tomato seedlings produced in different types of seedling trays. The experiments were done in 2008 and 2011 in a Richel greenhouse at Brăila. For the development of experimental model we used seeds from five tomato hybrids: Buran, Platus, Magnus, Maximus and Shanon. The seeds were sown in Biolan peat in two types of seedling trays, one with 144 cells and the other with 160 cells. There have resulted 10 experimental variants cultivated in three repetitions. We measured the photosynthesis intensity with a CO_2 analyser and the obtained data were statistically interpreted to highlight the differences that occur between studied variants.

Keywords: photosynthesis, seedling, tomato, seedling trays, mechanized.

Rezumat. Aspecte privind fotosinteza unor răsaduri de tomate produse mecanizat. Pentru a mări calitatea culturii este absolut necesar să îmbunătăţim metodele de producere a răsadurilor. Această lucrare se referă la procesul de fotosinteză al răsadurilor de tomate produse în diferite tipuri de palete alveolare. Experimentul a fost realizat în anii 2008 şi 2011 într-o seră tip Richel la Brăila. Pentru realizarea modelului experimental am folosit cinci hibrizi de tomate: Buran, Platus, Magnus, Maximus şi Shanon. Semănatul a fost realizat în turbă Biolan în palete alveolare cu 160, respectiv 144 de celule. Au rezultat 10 variante experimentale cultivate în trei repetiţii. A fost măsurată intensitatea fotosintezei cu un analizor de CO_2, iar datele obţinute au fost interpretate statistic pentru a evidenţia diferenţele care apar între variantele studiate.

Cuvinte cheie: fotosinteză, răsad, tomate, palete alveolare, mecanizat.

INTRODUCTION

In the latest years, there were made researches for finding new, modern solutions regarding the economic efficiency insurance, optimum seeds germination, the reduction of seeds lost, early crop, the elimination of some costs and the reduction of hand work (ULEANU *et al*., 2008).

Transplants for vegetable and crops are produced in a number of various sized containers or cells. Varying container size alters the rooting volume of the plants, which can greatly affect plant growth (MUŞA *et al*., 2011). Container size is important to transplant producers as they seek to optimize production space. Transplant consumers are interested in container size as it relates to optimum post-transplant performance (NESMITH & DUVAL, 1998).

In general, as container size increases plant leaf area, shoot biomass and root biomass increase (CANTLIFFE, 1993). Growth rates of shoots and roots are interdependent (TONUTTI, 1990). Roots rely upon plant aerial portions for photosynthates and various hormones, while plant aerial portions rely on the roots for water, nutrients, support, and hormones.

The information has been only a few, and only in recent years the importance of pot size for plant photosynthetic matter production was shown with scientific data by ARP in 1991. The author collected data of pot size and data related to photosynthetic matter production from a number of studies that had conducted high CO_2 treatment experiments in potted plants, and reported that there were roughly positive correlations between pot size and leaf photosynthetic rate.

Smaller pots decreased leaf photosynthetic rate and stomatal conductance and increased leaf starch content (THOMAS & STRAIN, 1991). To obtain more information of how pot size affects plant photosynthetic matter production, it is important to alter pot size directly (BOARD & KAHLON, 2011; CARDOSO *et al*., 2011).

This paper was made as a comparative study of the tomato seedlings obtaining methods (in different type's seedling trays) concerning their recommendation into the small, medium and big farms. The purpose of this study is the prominence of the differences of the tomato seedlings obtaining methods for the protected culture.

MATERIAL AND METHODS

For the realization of experimental model we used seeds from *Lycopersicon esculentum* MILL: A:

- A1-Buran - is an early hybrid with indeterminate growth, vigorous, with an open port allowing good light penetration. Fruits are large, 200-230 g, very firm and uniform, round, flattened, dark red at maturity. Highly productive well adapted to difficult growing conditions, suitable for culture in protected and field;

- A2-Platus - is the most cultivated hybrid in Europe, ideal for early crops and has a short period of ripening fruit. Fruits have a nice colour, are firm and weighing 130-140g. The plant is ventilated and requires a small workload, can be conducted on one or two arms. It can be grown all year round in greenhouses, solariums or field and is ideal for two crops per year;

- A3-Magnus - is one of the most important hybrids grown in eastern and southern Europe, due to very good resistance to disease and fruit quality. The plant is released, vegetative growth is stronger than at Platus, which allows cultivation and three branches in the autumn. Fruits have a weight of 140-160 g. Recommended for greenhouses and solariums poorly heated or unheated, and allowing two cycles of culture;

- A4-Maximus - is grown under the same conditions as Platus with a high quality of the fruit (colour, shape, firmness). Average weight of fruit is 130 g;

- A5-Shanon - is an early tomato hybrid with indeterminate growth, with large fruits (150-170 g), very uniform, suitable for growing in open fields or winter crops with a very high resistance to cold.

The seed were sown mechanized with MAS horticulture machine in Biolan peat in two types of seedling trays, B: B1- with 160 cells (28 ml volume) and B2- with 144 cells (16 ml volume) (Photo 1). The seedlings were properly cared throughout their production period.

The determination of photosynthesis intensity was made with S151 CO_2 analyser (Photo 2). It measures the concentration of CO_2 in the air is passed through the assimilation chamber in which the seedlings are arranged, compared with CO_2 in the air before passing through the assimilation chamber. The device comes with storage bag, hence the air that will be used to determine (to avoid influences caused by people around). Air is pumped into the unit using an electric pump, which can adjust air flow (in our case, 400 ml/min).

Photo. 1. Seeding machine. / Foto 1. Maşina de semănat. (original).

Photo. 2. S151 CO_2 analyser with tomato seedlings. / Foto 2. Analizorul de CO_2 S151 cu răsad de tomate (original).

The experimental variants are represented each by ten plants. There have resulted 10 experimental variants cultivated in three repetitions.

Table 1. Experimental variants. / Tabel 1. Variante experimentale.

Variant	Variable factors	
	A – Variety	B – the way the seedlings were produced
V.1	A.1	B.1
V.2	A.1	B.2
V.3	A.2	B.1
V.4	A.2	B.2
V.5	A.3	B.1
V.6	A.3	B.2
V.7	A.4	B.1
V.8	A.4	B.2
V.9	A.5	B.1
V.10	A.5	B.2

RESULTS ANS DISCUSSIONS

The intensity of photosynthesis was studied due to the influence of the variety and the seedling tray type. For statistical capitalization, all primary results were systematically listed in a table (ARDELEAN *et al*., 2002).

The tomato studied varieties photosynthesis intensity ranged between 2.69 to 6.41, its highest recorded level of 6.41 being registered in case of V5, followed by 5.92 to V3 (Table 2).

Variance analysis establishes to ensure statistical differences between variants (JITĂREANU, 2006). From the variance analysis for variant and error it results differences significance, established after calculating the factor F of Fisher's exact test.

Calculated F factor is greater than the theoretical F factor for $p<5\%$ (2.46) and 1% (3.60), Fisher's exact test is significant, differences go beyond errors, and researched factors contribute greatly to variation in results (Table 3).

We continued the calculations for determining the error differences (differences standard deviation), limit differences for all significance thresholds (DL 5%, DL 1% and DL 0.1%) and the significance of differences between variants and experience average (Table 4).

Table 2. Photosynthesis intensity average (µmol $CO_2/m^2/s$). / Tabel 2. Media intensităţii fotosintezei (µmol $CO_2/m^2/s$).

Variant	Photosynthesis intensity average (µmol $CO_2/m^2/s$)
V1:A1.B1	2.88
V2:A1.B2	2.69
V3:A2.B1	5.92
V4:A2.B2	5.54
V5:A3.B1	6.41
V6:A3.B2	4.99
V7:A4.B1	3.54
V8:A4.B2	2.99
V9:A5.B1	5.59
V10:A5.B2	4.61

Table 3. Tomato photosynthesis intensity variance analysis for variants and error. / Tabel 3. Analiza varianţei pentru variante şi eroare în cazul intensităţii fotosintezei la tomate.

Variability cause	SP	GL	The variance (s^2)	Fisher's exact test	Ft	
					F 5%	F 1%
Total	57.06	29	1.968	-	-	-
Repetition	0.39	2	0.195	-	-	-
Variants	51.94	9	5.772	21.97>2.46;3.60	2.46	3.60
Error	4.73	18	0.263	-	-	-

Table 4. The significance of differences between variants and experience mean for tomato photosynthesis intensity. / Tabel 4. Semnificaţia diferenţelor dintre variante şi media experienţei pentru intensitatea fotosintezei la tomate.

No.	Variability cause	Average	% relative towards Ea	±d towards Ea	Differences		Significance
					+	-	
1	V1:A1,B1	2.88	63.70	-1.64	-	ooo	very significant
2	V2:A1,B2	2.69	59.50	-1.83	-	ooo	very significant
3	V3:A2,B1	5.92	63.70	1.40	**	-	distinctly significant
4	V4:A2,B2	5.54	122.76	1.03	*	-	significant
5	V5:A3,B1	6.41	142.02	1.90	***	-	very significant
6	V6:A3,B2	4.99	110.43	0.47	ns	-	insignificant
7	V7:A4,B1	3.54	78.39	-0.98	-	o	significant
8	V8:A4,B2	2.99	66.29	-1.52	-	oo	distinctly significant
9	V9:A5,B1	5.59	123.79	1.07	*	-	significant
10	V10:A5,B2	4.61	102.02	0.09	ns	-	insignificant
11	Experience average (Ea)	4.42	100	-	-	-	-

Legend: DL 5% = 0.94; DL 1% = 1.29; DL 0.1% = 1.76; + = positive differences; - = negative differences.

The seedlings sown in seedling trays with 28 ml volume of cell had higher values of that process than the other with 16 ml volume. Buran presents very significant differences than the experience average for the two types of seedling trays and for the average too and Magnus presents very significant differences than the experience average for the seedling trays with 144 cells (28 ml volume).

CONCLUSIONS

The tomato studied varieties photosynthesis intensity ranged from between 2.69 to 6.41, its highest recorded level being of 6.41 in case of V5, followed by 5.92 at V3 (Fig. 1).

The variants V1, V2 and V5 present very significant differences than the experience average; V3 and V8 present distinctly significant differences; V4, V7 and V9 present significant differences, but V6 and V10 present insignificant differences than the experience average.

The seedling tray cell volume is important for the intensity of the photosynthetic process; the seedlings sown in seedling trays with 28 ml volume of cell had higher values of that process than the other with 16 ml volume.

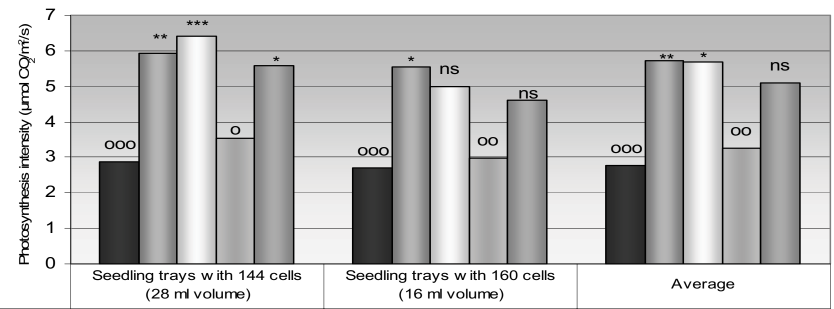
Small cell restrict root growth with implications on aerial part, photosynthesis being affected.

Buran presents very significant differences than the experience average for the two types of seedling trays and for the average too.

Magnus presents very significant differences than the experience average for the seedling trays with 160 cells (28 ml volume).

Magnus and Platus had the highest intensity of photosynthesis, followed by Shannon and Maximus. Buran has recorded the lowest intensity of photosynthesis.

I recommend using seedling tray with larger alveolar cell at the expense of small ones and hybrids Magnus, Platus and Shannon.



	Seedling trays with 144 cells (28 ml volume)	Seedling trays with 160 cells (16 ml volume)	Average
Buran	2.88	2.69	2.78
Platus	5.92	5.54	5.73
Magnus	6.41	4.99	5.7
Maximus	3.54	2.99	3.26
Shanon	5.59	4.61	5.1

Figure 1. The differences between seedlings sown in seedling trays with 144 cells (28 ml volume) - B1 and seedlings sown in seedling trays with 160 cells (16 ml volume) - B2 / Figura 1. Diferenţele între răsadurile semănate în palete alveolare cu 144 de celule (cu volum de 28 ml) - B1 şi răsadurile semănate în palete alveolare cu 160 de celule (cu volum de 16 ml) - B2.

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